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EXAMINER	
JOHNSON, KEVIN M	

ART UNIT	PAPER NUMBER
1793	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/538,300	FORD ET AL.	
	Examiner	Art Unit	
	KEVIN M. JOHNSON	1793	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *12/31/2007*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *53-99* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *53-73,75-79,81,82 and 84-99* is/are rejected.

7)☒ Claim(s) *74, 80 and 83* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *10 June 2005* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *6/10/2005*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Objections

1. Claim 55 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. As all carbon nanotubes are either single-walled or multi-walled, restricting the carbon nanotubes of the independent claim to single-walled or multi-walled nanotubes does not further limit the previous claim.

Claim Rejections - 35 USC § 112

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claim 99 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

5. Claim 99 provides for the use of a soluble carbon nanotube, but, since the claim does not set forth any steps involved in the method/process, it is unclear what method/process applicant is intending to encompass. A claim is indefinite where it

merely recites a use without any active, positive steps delimiting how this use is actually practiced.

Claim 99 is rejected under 35 U.S.C. 101 because the claimed recitation of a use, without setting forth any steps involved in the process, results in an improper definition of a process, i.e., results in a claim which is not a proper process claim under 35 U.S.C. 101. See for example *Ex parte Dunki*, 153 USPQ 678 (Bd.App. 1967) and *Clinical Products, Ltd.* v. *Brenner*, 255 F. Supp. 131, 149 USPQ 475 (D.D.C. 1966).

Claim Rejections - 35 USC § 103

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. The factual inquiries set forth in *Graham* **v.** *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

8. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation

under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

9. Claims 53-63, 75-78 and 91-95 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haddon et al. (US 6368569) in view of Lavin et al. (US 6426134) and Lieber et al. (US 6159742).

In regard to claims 53-55, 59-60, 76 and 77, the claims are drawn to a method of producing solubilized carbon nanotubes (CNTs) comprising the steps of providing CNTs and urea, mixing the CNTs and urea and heating the mixture to initialize a polymerization reaction of the isocyanic acid and/or cyanate ion produced by the urea that occurs at oxygenated functional groups one the sides and ends of the CNTs.

Haddon teaches a method of solubilizing CNTs in organic solutions. The method comprises a purification step that adds carboxylic acid functionalities to the CNTs and a chemical modification step that attaches long aliphatic carbon chains to the CNTs at the carboxylic acid functional groups that renders the CNTs soluble in some organic solutions (column 3, lines 29-35). Haddon fails to teach that the polymer can be polymerized at the same time as the nanotubes are functionalized and that urea can be used as a monomer precursor.

Lavin teaches a method of forming a CNT-polymer composite. The method comprises the steps of derivatizing the CNTs with an acid so that at least one carboxylic acid group is attached to each CNT, contacting the derivatized CNTs with polymer

precursors to form a pre-polymer product and polymerizing the pre-polymer product to form a CNT-polymer composite (column 2, lines 1-14). Haddon teaches that the polymerization reaction takes place under the pressure and temperature conditions necessary for the particular polymer precursors present, including the possible addition of a catalyst (column 5, lines 35-40). The use of an isocyanate as a polymer precursor is possible when mixed with amine-derivatized CNTs to form a CNT polyurethane composite (column 5, line 67 - column 6, line 3). Lavin fails to teach that the isocyanate can react directly with the carboxylic acid functional group, or that urea can supply the isocyanate.

Lieber teaches the functionalization of a CNT to produce a tip for scanning probe microscopy. Lieber teaches that an isocyanate may be attached to the CNT by linking directly to a carboxylic acid group on the end of the CNT (column 4, lines 34-37).

Applicant admits that urea is commonly used in the art as a source of isocyanic acid (page 6 of the specification).

It would have been obvious to one skilled in the art at the time of the invention that the process as taught by Haddon could be modified so that the polymer is formed concurrently with the functionalization of the CNTs as taught by Lavin, with the polymerization reaction initiated by heating the mixture. Such a modification would be motivated by the suggestion in Lavin that temperature can be used to initiate the polymerization reaction and the desire to simplify the process as taught by Haddon by utilizing less complex raw materials, simple monomers as taught by Lavin as opposed to the more complex polymers taught by Haddon. It would have been further obvious

that isocyanate could be reacted directly with the carboxylic acid functional group on the CNT as taught by Lieber as opposed to with the amine functionalized CNT as taught by Lavin. Such a modification would have been motivated by the simplification of the process, as Lieber teaches that amine functionalization of the CNTs is not necessary for reaction with isocyanates. It would have been obvious to one skilled in the art that urea could be utilized as a precursor to the isocyanate (isocyanic acid) taught by Lavin and Lieber. This modification would have been motivated by the ready availability of urea, a well known source of isocyanic acid.

In regard to claims 56-58, it would have been obvious to one skilled in the art at the time of the invention to utilize CNTs in the process that have approximately 1 per 100 carbon atoms in an oxidized state. This result would have been achieved in the course of routine optimization of the process as obviated by Haddon, Lavin and Lieber. Optimization of the oxidized carbon atom ratio would have occurred because in the process the oxidized carbon atoms provide sites for the functionalization of the CNTs, and therefore the amount of functionalization, and the properties it imparts, that occurs is directly correlated to the number of oxidized carbon atoms.

In regard to claim 61, Lavin teaches that the monomer may be supplied in an aqueous solution (column 6, lines 56-57).

In regard to claim 62, Lavin teaches that the nanotubes may be suspended in dimethyl formamide (DMF) after the purification step, but before they are supplied to the acid treatment step (column 3, lines 62-65).

In regard to claim 63, it would have been obvious to one skilled in the art at the time of the invention that DMF can be heated to a temperature greater than the melting point of urea (132.7°C) without decomposing, as the boiling point of DMF is 153°C.

In regard to claim 75, it would have been obvious to one skilled in the art at the time of the invention that an alcoholic solution could be used to dissolve the modified CNTs, as Haddon teaches that the modified CNTs are soluble in organic solvents.

In regard to claim 78, it would have been obvious to one skilled in the art at the time of the invention that the urea must be heated to its melting point, as it is necessary to heat urea to above its melting point to cause it to dissociate and provide isocyanic acid.

In regard to claims 91-95, it would have been obvious to one skilled in the art at the time of the invention that it would necessarily follow that a CNT treated in the method obviated by Haddon, Lavin and Lieber would meet the requirements of the claims. By utilizing the same method and the same materials, the same product is produced.

10. Claims 64-73, 79, 81-82, 84-90 and 96-98 are rejected under 35 U.S.C. 103(a) as being unpatentable over Haddon, Lavin and Lieber as applied to claims 53 and 76 above, and further in view of Georgakilas et al. (J. Am. Chem. Soc., Vol. 124. No. 5, 2002, pp 760-761).

In regard to claims 64 and 81, Georgakilas teaches a method of functionalizing nanotubes by the addition of aldehydes. The method comprises the steps of combining excess aldehyde and a modified glycine with CNTs that are suspended in DMF and

heating the resulting mixture (p 760, column 1). Functionalized CNTs produced by the method are very soluble in water and methanol (p 760, column 1). It would have been obvious to one skilled in the art at the time of the invention to add an aldehyde functionalization as taught by Georgakilas to the method taught by Haddon, Lavin and Lieber. Such a modification would have been motivated by the desire to further solubilize the CNTs, as Haddon teaches solubility in organic solvents while the method taught by Georgakilas is provides CNTs that are further soluble in water.

In regard to claims 65 and 82, Georgakilas teaches that after the addition of the aldehyde mixture to the CNTs, the mixture is heated to effect the functionalization reaction (p 760, column 1).

In regard to claims 66-69 and 84-87, the aldehyde used in the method taught by Georgakilas is either formaldehyde or 4-methoxybenzaldehyde. It would have been obvious to one skilled in the art at the time of the invention that the methoxy group in the 4-methoxybenzaldehyde is an electron-donating group of the type required by the claims that is located in the para-position.

In regard to claims 70 and 88, it would have been obvious to one skilled in the art to substitute 4-propoxybenzaldehyde for the 4-methoxybenzaldehyde taught by Georgakilas. This substitution would have been obvious because methoxy and propoxy groups are considered to be obvious variants.

In regard to claims 71, 72, 89 and 90, Georgakilas states that the functionalized CNTs are highly soluble in methanol. The functionalized nanotubes are separated from the reaction solution by centrifugation and filtration (p 761, reference 21). It would have

been obvious to one skilled in the art at the time of the invention that Georgakilas must have dissolved the functionalized nanotubes in a methanol solution after the functionalization process was complete to discover this property.

In regard to claim 73, Haddon teaches that a membrane may be used for filtration that has a pore size of 0.2 μm (column 4, lines 56-57).

In regard to claim 79, Georgakilas teaches that the reactant mixture is heated to 130°C (p 760, column 1).

In regard to claims 96-98, it would have been obvious to one skilled in the art at the time of the invention that it would necessarily follow that when utilizing a method as obviated by Haddon, Lavin, Lieber and Georgakilas would meet the requirements of the claims. By utilizing the same method and the same materials, the same product is produced.

Allowable Subject Matter

11. Claims 74, 80 and 83 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 74 are differs from the prior art in that there is no teaching or suggestion in the prior art that an amine reactive compound should be added to the modified carbon nanotubes after the polymerization step.

Claim 80 differs from the prior art in that the closest prior art examples, cited previously in this office action, the reactant mixture is heated for long periods of time, at the least 90 minutes and in many cases for multiple days. There is no teaching or

suggestion that would provide motivation that would lead one skilled in the art to select a heating time of 1-60 minutes as required by the claim.

Claim 83 is distinct from the prior art in that the aldehyde is added after the heating step is initiated. There would be no motivation for one skilled in the art to add the aldehyde component after the start of the heating process, as the prior art teaches the aldehyde is added prior to the heating of the mixture.

Conclusion

12. Claims 53-73, 75-79, 81, 82 and 84-99 are rejected.

13. Claims 74, 80 and 83 are objected to, as they are dependent on a rejected base claim.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to KEVIN M. JOHNSON whose telephone number is (571)270-3584. The examiner can normally be reached on Monday-Friday 7:30 AM to 5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jerry Lorengo can be reached on 571-272-1233. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

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